DOCUMENT RESUME

ED 312 154 SE 051 006

TITLE	Insulation Fact Sheet.
INSTITUTION	Conservation and Renewable Energy Inquiry and Referral Service (DOE), Silver Spring, MD.
REPORT NO	DOE/CE-0180
PUB DATE	Jan 88
NOTE	14p.; Drawings and shaded pages may not reproduce well.
PUB TYPE	Guides - Non-Classroom Use (055)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Energy; *Energy Conservation; Energy Education; *Energy Management; Environmental Standards; *Heating
IDENTIFIERS	*Insulation

ABSTRACT

Heating and cooling account for 50-70% of the energy consumed in the average American home. Heating water accounts for another 20%. A poorly insulated home loses much of this energy, causing drafty rooms and high energy bills. This fact sheet discusses how to determine if your home needs more insulation, the additional thermal resistance (called R-value) you would need, and what kind of insulation you should buy. It describes options for installing insulation, including do-it-yourself installation, and selecting a professional. A list of agencies and organizations providing more information about energy conservation and nine references are given. (YP)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED312154

DOE/CE-0180

Fact Sheet:

Insulation

Conservation and Renewable Energy
Inquiry and Referral Service

Department of Energy
Silver Spring, MD

January, 1988

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

SE 051 004

BEST COPY AVAILABLE

DOE/CE-0180
January 1988

How Does Insulation Work for You? 2

4 Determining The R-Value You Need

What Kind of Insulation Should You Buy? 9

Department of Energy
Assistant Secretary
Conservation and Renewable Energy

Insulation Fact Sheet

In this issue:

Introduction 1

How Does Insulation Work for You? 2

Does Your Home Need More Insulation? 4

Determining The R-Value You Need 4

Before You Insulate 6

What Kind of Insulation Should You Buy? 9

Making Your Selection 10

Check The Label Before You Buy 10

Can You Do It Yourself? 10

If You Do It Yourself 10

If You Have It Done Professionally 11

Other Places in Your Home for Added Insulation 11

Information Services 12

INTRODUCTION

Electricity bills, oil bills, gas bills—all homeowners pay for one or more of these utilities, and wish they paid less. Perhaps because we grew up when energy prices were low, most of us don't really know how to control our utility bills. We resign ourselves to high bills because we think that is the price we have to pay for a comfortable home. We nag our children to turn off the lights and appliances, but put off insulating the attic.

Why Should You Insulate?

Why is it foolish to postpone an insulating project? Because lighting and appliances account for a very small proportion of the energy used in most residences. On the other hand, 50% to 70% of the energy used in the average American home is for heating and cooling ("space conditioning"). Another 20% goes for heating water. Everything else combined accounts for just 10% to 30% of your utility bills. It doesn't make sense to leave lights and appliances on when they are not needed, but if you want to substantially reduce energy costs, decreasing the amount of energy needed for heating and cooling is a good place to start.

Unless your home was constructed with special attention to energy conservation, adding insulation could probably reduce your utility bills. Most of the exist-

ing housing stock in the United States is not insulated to the optimal (best) recommended levels. Older homes are more likely to have the obvious drafts that mean sky-high heating and air-conditioning bills, but even if you own a new home, adding insulation may save enough money in reduced utility bills to pay for itself within a few years, and then continue to save you money for as long as you own the home.

The Crucial Role of Thermal Insulation

Air leakage, moisture infiltration, and inadequate insulation are the leading causes of energy waste in most homes built before the 1973 Arab oil embargo, and in many built since then.

Insulation not only saves money and helps to reduce the rate of depletion of our nation's limited energy resources, it can make your home more comfortable. Insulation helps maintain a uniform temperature throughout the house. Walls, ceilings, and floors will be warmer in the winter and cooler in the summer. Fewer drafts mean the house will remain comfortable at lower thermostat settings. Insulation also acts as a sound absorber, keeping noise levels down.

It is possible to add insulation to almost any house. Whenever structural framing is accessible — for instance, in unfinished attics or under the floor over an unheated space — installation can be a do-it-yourself project. Or you may prefer to hire a qualified contractor. In either case, it is important to choose and install the insulation correctly.

The amount of energy you conserve will depend on several factors: your local climate; the size, shape, and construction of your house; the living habits of your family; the type of heating and cooling system; and the fuel you use. Once the installation cost is offset, energy conserved is money saved — and the savings will increase as electrical power and fuel prices increase.

Some states offer a tax credit for money spent on measures to reduce home energy use, including added insulation, weatherstripping, and caulking. Local utility companies often provide technical advice and some offer rebates or financing assistance. State energy offices are another valuable resource for information. An energy audit of your house will identify the amount of insulation you have and need, and will likely recommend other improvements such as installing storm windows over existing single- and double-pane windows.

Thermal Insulation in Your Home

If you are buying or building a new house, you can make sure that recommended energy-saving features are included. The Federal Trade Commission (FTC) home insulation rule, which went into effect in 1980, requires the seller of a new home to provide information on the type, thickness, and R-value of the insulation that will be installed in each part of the house in every sales contract. Insulation contractors are required to give their customers similar information.

To keep initial selling prices competitive, many home builders offer standard (not optimal) levels of insulation, although additional insulation would be a good investment for the buyer. Home builders, who design and construct their houses in accordance with guidelines published by the National Association of Home Builders (NAHB), insulate to recommended levels or provide other energy conservation features that yield equivalent results.

Figure 1 shows which building spaces should be insulated. Discuss the house plans with your builder, and make sure each of these spaces is insulated to the R-values recommended for your Insulation Zone. Tables 2, 3, and 4 give the information required to determine recommended R-values.

Best results are obtained when the recommended levels of thermal insulation are installed during initial construction rather than added later. The exception is in extreme climates, where super-energy-efficient designs can make economic sense. Higher-than-usual levels of insulation are installed to achieve a practical minimum of heating and cooling energy use and cost. Because the super-energy-efficient houses are sealed so tightly, controlled mechanical ventilation with heat recovery features are necessary. These super-energy-efficient homes also often include window systems designed to control heat flow and to maximize solar benefits; well-sealed vestibules and doors; energy-efficient water heaters, refrigerators, and other appliances.

Insulation Priorities

It is most important to:

- *Insulate your attic* to the recommended level, including the attic door, or hatch cover.
- Provide the recommended level of insulation *under floors above unheated spaces, and around walls in the basement, crawl spaces, and foundation, and on the edges of slabs-on-grade.*
- Consider exceeding the recommended levels of insulation for *exterior walls* of existing houses, particularly when remodeling or re-siding your house, or for new houses.

HOW DOES INSULATION WORK FOR YOU?

Heat flows naturally from a warmer to a cooler space. In the winter, this heat flow, or heat transfer, moves from all heated living spaces to adjacent unheated attics, garages, and basements, or the outdoors; or through interior ceilings, walls, and floors — wherever there is a difference in temperature. In the cooling season, the heat flow is often in the opposite direction, especially in air-conditioned buildings. During every season of the year heat is flowing through the building envelope — (the roof, walls, and earth contact) — to or from the outdoors. To maintain comfort, the heat lost must be replaced by your heating system and the heat gained must be removed by your air conditioner. Insulation of ceilings, walls, and floors decreases this heat transfer by providing an effective resistance to the flow of heat.

The effectiveness of insulation is measured in terms of thermal resistance, called R-value, which indicates the resistance to heat flow. The higher the R-value, the greater the insulating power. The actual R-value of thermal insulation depends on the type of material, its thickness and density. In calculating the R-value of an installation, the R-values of the individual layers are added. Installing more insulation in your home increases resistance to heat flow.

Figure 1. **Examples of Where to Insulate**

1. In unfinished attic spaces, insulate between the floor joists to seal off living spaces below.*

2. In finished attic rooms with or without dormers, insulate...
   - 2A between the studs of "knee" walls;
   - 2B between the studs and rafters of exterior walls;
   - 2C ceilings with cold spaces above.

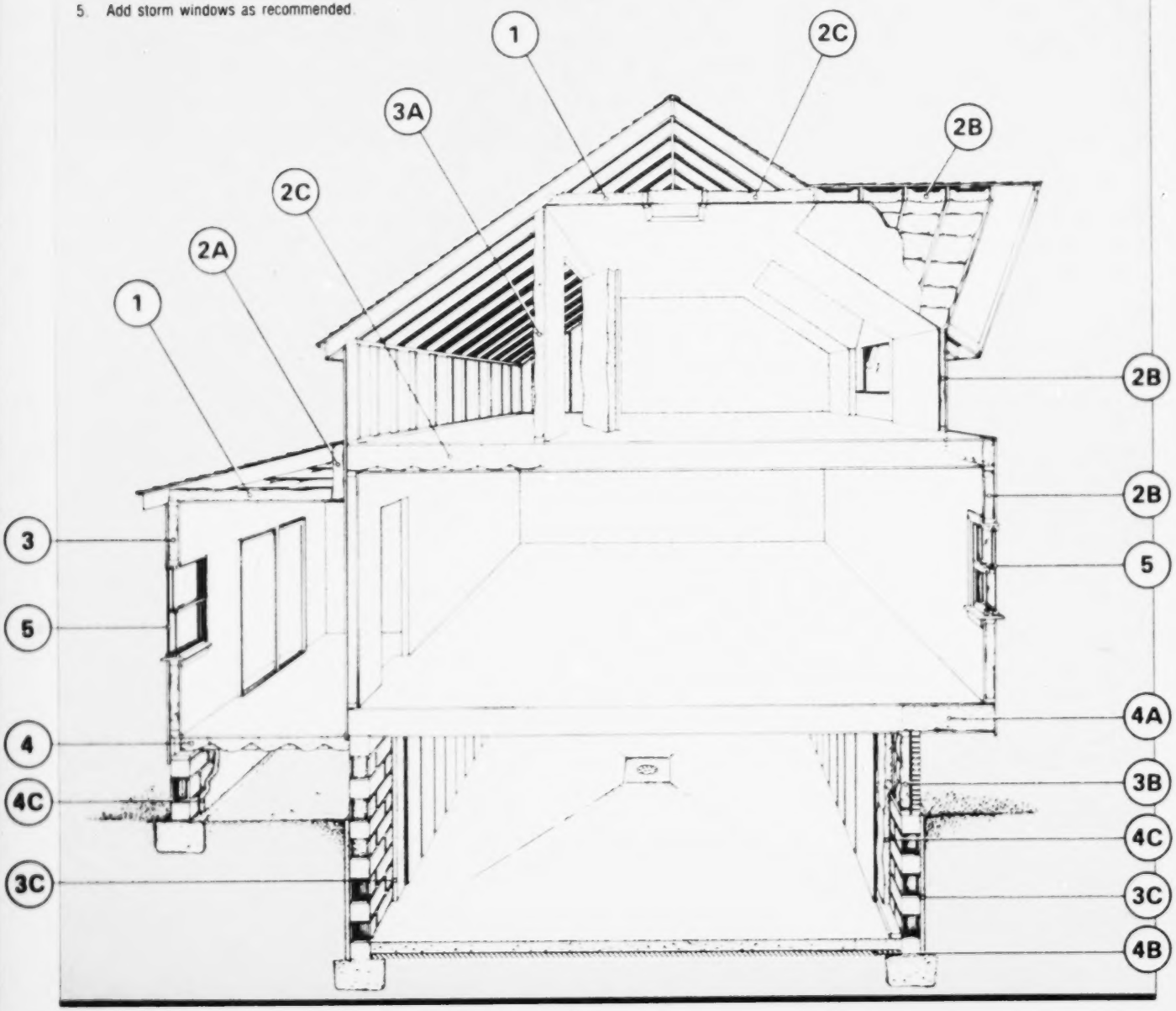
3. All exterior walls, including...
   - 3A walls between living spaces and unheated garages or storage areas;
   - 3B foundation walls above ground level;
   - 3C foundation walls in heated basements. (In certain extremely cold climates of northern Maine, Minnesota, and Alaska, specialists should be consulted for foundation wall insulation.)

4. Floors above cold spaces, such as vented crawl spaces and unheated garages. Also insulate...
   - 4A any portion of the floor in a room that is cantilevered beyond the exterior wall below;
   - 4B slab floors built directly on the ground.**
   - 4C foundation walls of crawl spaces and perimeter plates.

5. Add storm windows as recommended.

* Well-insulated attics, crawl spaces, storage areas, and other closed cavities should be well-ventilated to prevent excessive moisture build-up.

** Slab on grade is almost always insulated, in accordance with building codes, when the house is constructed.



DOES YOUR HOME NEED MORE INSULATION?

To begin to answer this question, you must first find out how much insulation you already have. (An insulation check is a routine part of an energy audit. You may wish to have a complete energy audit made by a qualified auditor. For information about home energy audits, call your local utility company.)

The next step is to determine how much more would be cost-effective. Because most older homes were built when energy was abundant and cheap, you may find that your house has little or no insulation; or that the amount of insulation is not adequate by today's standards. Look at Figure 1, which shows the places in a typical house where insulation should be installed. These are the areas you should check first.

First, check the attic; then check walls and floors next to unheated spaces like a garage or basement. In an attic where the structural frame elements (the ceiling joists) are exposed, simply measure the depth or thickness of the insulation. Then identify the type of insulation (see "Types of Insulation – Basic Forms" in Table 1).

Mineral fiber loose-fill insulation is produced from either molten glass or slag. Fiberglass insulation is usually very light, and colored yellow, pink, or white. Rockwool loose-fill is usually heavier than fiberglass, and is most commonly grey with black specks (shot). Some rock wool products, however, are near-white, with a very small amount of shot. Loose-fill cellulosic insulation is commonly manufactured from waste newspaper, cardboard, or other forms of waste paper. The cellulosic insulations have added chemical fire retardants, and are in the form of small flat pieces rather than fibers. Vermiculite- and perlite-loose-fill insulations are produced by expanding micaceous or siliceous minerals by grading and heating. The resulting granules are non-combustible and are poured-in-place.

It is more difficult to inspect finished exterior walls. One method is to use an electrical outlet on the wall, but first be sure to turn off the power to the outlet. Then remove the coverplate and shine a flashlight into the opening to see how much, if any, insulation is in the wall. An alternative is to remove and then replace a small section of the exterior sheathing.

Inspect and measure the thickness of any insulation in unfinished basement ceilings and walls, or above crawl spaces. Then compare your findings with recommended levels of insulation by following the steps described next.

DETERMINING THE R-VALUE YOU NEED

The amount of insulation you need depends on the climate, type of heating (gas, oil, electricity) you use, and the section of the house that you plan to insulate. The attic needs to be insulated to the highest R-value because of its critical location in the upward heat flow pattern.

Tables 1 and 2 will help you to identify the type of insulation and its R-value as presently installed. Determine the kind of insulation you have from Table 1, and circle it on Table 2. Then, reading down the circled column, find your thickness and circle it. The R-value of your insulation is shown in the left column.

The next step is to compare the R-value of your insulation with the recommended total R-value for your house and your type of space heating, as given in Table 4. Do this for each part of the house that you plan to insulate, because the installed R-values may not be the same.

Find the first three numbers in your zip code in Table 3 to determine your insulation zone number. Then, using Table 4, locate your insulation zone number in the left column. Reading across this line, find the recommended R-values for the various parts of your house, and for the type of space heating in your home. Having determined these recommended R-values, subtract the R-value of the insulation already in your home. The result will be the R-value you should add.

By checking Table 2 again, you can convert this R-value to the inches of thickness required for the type of insulation you have decided to use. When buying insulation, always go to the next standard size. For example, if you need to add 5 inches, the standard size to add is 6 inches.

For example, Table 3 shows that a homeowner in a zip code area beginning with 522 lives in insulation zone 7. If gas is used for space heating, then the recommended R-value for attic floor insulation is R-38. If the existing attic floor insulation has an R-11 insulation value, then an additional R-27 would be needed to bring the attic floor insulation up to the level recommended for that climate. The homeowner then would check Table 2 to find several choices. Table 2 does not include R-27, but does include R-30, which would become the recommended R-value addition. For example, one could add a 9 to 9 1/2 inch thick batt or blanket of mineral fiber, or 11 to 14 inches of loose-fill fiberglass, or 10 1/2 inches of loose-fill cellulosic fiber.

Table 4 provides recommended total R-values for existing houses. The recommendations are based on an analysis of cost-effectiveness, using average local energy prices, insulation costs, equipment efficiencies, climate factors, and energy savings for both the heating and cooling seasons. The recommendations are based on the assumption that no structural modifications are needed to accommodate the added insulation.

For ceilings and floors, it is not usually cost-effective to upgrade insulation by only one level, such as from R-11 to R-19, unless you do it yourself and there is no labor charge. If side walls and floors have space to accommodate more insulation than recommended, it *may* be cost-effective to do so, especially in colder climates.

Making Your Decision

The amount of money you are willing to invest in insulation will of course depend on your personal finances. But remember that the initial investment will

Table 1: **Types of Insulation — Basic Forms**

Form	Method of Installation	Where Applicable	Advantages	Materials
Blankets or Batts	Fitted between wood-frame studs, joists and beams	All unfinished walls, floors and ceilings	Do-it-yourself Suited for standard stud and joist spacing, which is relatively free from obstructions Blankets: Little waste because it's handcut Batts: More waste, but easier to handle than large rolls	Rock wool Glass Fiber
Loose-Fill (poured in)	Poured between attic joists	Unfinished floors and hard-to-reach places Irregularly shaped areas and around obstructions	Do-it-yourself Easy to use for irregularly shaped areas and around obstructions	Rock wool Glass fiber Cellulose Fiber Vermiculite Perlite
Blown In	Blown into place or spray applied by special equipment	Anywhere that frame is covered on both sides, such as side walls Unfinished attic floors and hard to reach places	The only insulation that can be used in finished areas Easy to use for irregularly shaped areas and around obstructions	Rock wool Glass fiber Cellulose fiber Urethanes
Rigid Insulation	Must be covered with 1/2-inch gypsum board or other finishing material for fire safety	Basement masonry walls Exterior walls under construction Exterior walls when adding siding	High insulating value for relatively little thickness	Polystyrene board Polyurethane board Isocyanurate board
Reflective Insulation	Fitted between wood-frame studs joists, and beams	All unfinished walls, floors, and ceilings	Do-it-yourself Suitable for standard stud and joist spacing, free from obstructions Little waste by hand cutting R-value depends on number of foils, air spaces, and positioning	Aluminum foil Foil-faced paper

pay for itself in reduced energy consumption, particularly where the amount already installed is substantially less than recommended. As fuel and electrical power costs rise, it makes even more sense to invest in insulation.

BEFORE YOU INSULATE

You Must Control Air Leakage

An indoor-outdoor exchange of about half of the house air volume every hour is needed to maintain an acceptable indoor air quality without controlled mechanical ventilation. Air exchange rates for pre-1973 houses are often more than this. Higher exchange rates can dramatically increase the amount of energy used for heating and cooling. Most homeowners are aware that air leaks into their houses through what seem to be small openings around doors and window frames; through gaps around electrical outlets and switchboxes, recessed fixtures, pull-down stairs, furred or false ceilings; and through fireplaces and chimneys. Heat transferred by this air leakage can be stopped by closing these openings, but will not likely reduce the air exchange below the recommended rate.

The spaces between the framing and the rough openings for doors and windows should be filled. Caulking and weatherstripping are effective ways to reduce air leakage. To determine if your home needs caulking, putty, or weatherstripping, check to see:

- If the joints where each window frame meets the wall on the outside of the house are completely caulked;
- If the putty around the individual window panes is solid and unbroken;
- If the weatherstripping around doors and windows is damaged or missing;
- If there are gaps around the ground sill.

Knowledgeable homeowners or carpenters can easily accomplish these repairs.

There are several steps to take before you cover your attic floor with insulation. Many attics have warm air leaking into the cooler attic space in winter from the living spaces below. *If these leakage paths are not blocked, the savings expected from adding floor insulation will be reduced substantially, due to air flow through the insulation.*

The following openings must be sealed before insulating:

- Around the chimney: pack gaps around an insulated chimney with unfaced rock wool or fiber-glass insulation. Do not insulate bare hot exhaust pipes. DO NOT USE ANY COMBUSTIBLE PRODUCTS OR CELLULOSIC INSULATION HERE.
- Around the attic trap door or entry door: weatherstrip the edges.
- *Areas above staircase ceilings and dropped ceilings*: staple a plastic sheet over the opening and tape it tightly around edges.
- *Around pipes and ducts penetrating wall or attic floor*: pack insulation into the gap.
- *Top openings of interior wall cavities*: staple a plastic sheet over the opening and tape it tightly around edges.

You Must Control Moisture

Moisture control is a major concern associated with installing thermal insulation. The warm air inside your house contains water vapor. If this vapor passes into the insulation and condenses it can cause significant loss of insulating value. If moisture becomes deposited in the building structure, it can cause mold growth, peeling paint, and eventual rotting of structural wood. To guard against moisture problems, use vapor retarders, provide adequate ventilation for the house, and ensure that there is a path for air movement to the outside from the wall cavity.

Vapor retarders are special materials including treated papers, plastic sheets, and metallic foils that reduce the passage of water vapor and prevent insulation and structural wood from becoming damp, and metals from corroding.

Table 2. **Thickness in Inches for Insulations To Obtain R-Values[1] (Inches)**

R-Value[2]	Mineral Fiber Blanket or Batts[3]	Loose and Blown Fill[4]			Perlite or Vermiculite
		Fiberglass	Rock wool	Cellulosic Fiber[5]	
R-11	3 1/4 - 3 3/4	4 - 5 1/4	3 1/2	3 3/4	3 - 4 1/2
R-19	5 3/4 - 6 1/4	7 - 8 3/4	6 1/4	6 1/2	5 1/2 - 7 3/4
R-30	9 - 9 1/2	11 - 14	9 3/4	10 1/2	8 1/2 - 12 1/4
R-38	11 1/2 - 12	14 - 17 3/4	12 1/4	13	10 1/2 - 15 1/2
R-49	15 - 15 1/2	18 - 23	16	17	13 3/4 - 20

1. Always consult the manufacturer's recommendations for applications, because specific products may deviate from these nominal thicknesses.
2. Rigid cellular insulating boards provide high R-values for a given thickness. Various thicknesses are available; 1-inch thick boards can have the nominal R-values given below.

Type	R-value for 1-inch
Polystyrene	
Expanded	4
Extruded	5
Polyisocyanurate and Polyurethane	6-7
Phenolic	8

3. Two blankets or batts may be needed for R-values above 30.
4. Failure to install both proper thickness and density will result in reduced R-value. An increased initial installed thickness may be required to offset any decreases in R-values due to thickness changes after installation.
5. These are initial thicknesses to allow for a nominal 20% thickness decrease after installation.

Always consult manufacturers' recommendations for applications, since specific R-values depend on foam density and aging.

Table 3. Zip Codes and Corresponding Insulation Zones* For Use With Recommendations in Table 4

If Your Zip Code Begins With These Three Numbers	Your Insulation Zone Is:
010	7
011	7
012	7
013	7
014	7
015	7
016	7
017	7
018	7
019	7
020	7
021	7
022	7
023	7
024	7
025	7
026	7
027	7
028	7
029	7
030	7
031	7
032	7
033	7
034	7
035	7
036	7
037	7
038	7
039	7
040	7
041	7
042	8
043	7
044	8
045	7
046	8
047	8
048	7
049	8
050	7
051	7
052	7
053	7
054	8
056	8
057	7
058	8
059	8
060	7
061	7
062	7
063	7
064	7
065	7
066	7
067	7
068	7
069	7
070	7
071	7
072	7
073	7
074	7
075	7
076	7
077	7
078	7
079	7
080	8
081	7
082	8
083	8
084	8
085	7
086	7
087	8
088	7
089	7
100	
100	7
101	7
102	7
103	7
104	7
105	7
106	7
107	7
108	7
109	7
110	7
111	7
112	7
113	7
114	7
115	7
116	7
118	7
119	7
120	7
121	7
122	7
123	7
124	7
125	7
126	7
127	7
128	7
129	7
130	7
131	7
132	7
133	7
134	7
135	7
136	7
137	7
138	7
139	7
140	7
141	7
142	7
143	7
144	7
145	7
146	7
147	7
148	7
149	7
150	7
151	8
152	7
153	8
154	8
155	8
156	7
157	7
158	7
159	8
160	7
161	7
162	7
163	7
164	7
165	7
166	7
167	7
168	8
169	7
170	8
171	8
172	8
173	8
174	8
175	8
176	8
177	7
178	8
179	8
180	8
181	8
182	8
183	8
184	8
185	8
186	4
187	4
188	4
189	4
190	4
191	4
193	4
194	4
195	4
196	8
197	4
198	4
199	4
200	
200	4
202	4
203	4
204	4
205	4
206	4
207	4
208	4
209	4
210	4
211	4
212	4
214	4
215	4
216	4
217	4
218	3
219	4
220	4
221	4
222	4
223	4
224	4
225	4
226	4
227	4
228	4
229	4
230	3
231	3
232	3
233	3
234	3
235	3
236	3
237	3
238	3
239	3
240	4
241	4
242	4
243	4
244	4
245	4
246	4
247	5
248	4
249	5
250	4
251	4
252	4
253	4
254	5
255	4
256	4
257	4
258	5
259	5
260	5
261	5
262	7
263	5
264	5
265	5
266	7
267	5
268	5
270	5
271	5
272	5
273	5
274	5
275	5
276	5
277	5
278	5
279	5
280	5
281	5
282	5
283	5
284	3
285	3
286	7
287	7
288	7
289	7
290	3
291	3
292	3
293	5
294	3
295	3
296	5
297	3
298	3
299	3
300	
300	3
301	3
302	3
303	3
304	2
305	5
306	3
307	5
308	3
309	3
310	3
312	3
313	2
314	2
315	2
316	2
317	2
318	3
319	3
320	2
322	2
323	2
324	2
325	2
326	2
327	1
328	1
329	1
330	1
331	1
332	1
333	1
334	1
335	1
336	1
337	1
338	1
339	1
350	3
351	3
352	3
354	3
355	3
356	5
357	5
358	5
359	3
360	3
361	3
362	3
363	2
364	2
365	2
366	2
367	3
368	3
369	3
370	5
371	5
372	5
373	5
374	5
376	7
377	5
378	5
379	5
380	5
381	5
382	5
383	5
384	5
385	5
386	3
387	3
388	3
389	3
390	3
391	3
392	3
393	3
394	3
395	2
396	3
397	3
400	
400	7
401	7
402	7
403	7
404	7
405	7
406	7
407	7
408	8
409	8
410	7
411	7
412	7
413	7
414	7
415	7
416	7
417	7
418	7
420	8
421	8
422	8
423	7
424	7
425	7
426	7
427	7
430	7
431	7
432	7
433	7
434	7
435	7
436	7
437	7
438	7
439	7
440	7
441	7
442	7
443	7
444	7
445	7
446	7
447	7
448	7
449	7
450	7
451	7
452	7
453	7
454	7
455	7
456	7
457	7
458	7
460	7
461	7
462	7
463	7
464	7
465	7
466	7
467	7
468	7
469	7
470	7
471	8
472	7
473	7
474	8
475	8
476	8
477	8
478	7
479	7
480	7
481	7
482	7
484	7
485	7
486	7
487	7
488	7
489	7
490	7
491	7
492	7
493	7
494	7
495	7
496	7
497	7
498	7
499	7
500	
500	7
501	7
502	7
503	7
504	7
505	7
506	7
507	7
508	7
510	7
511	7
512	7
513	7
514	7
515	7
516	7
520	7
521	7
522	7
523	7
524	7
525	7
526	7
527	7
528	7
530	7
531	7
532	7
534	7
535	7
537	7
538	7
539	7
540	7
541	7
542	7
543	7
544	7
545	7
546	7
547	7
548	7
549	7
550	7
551	7
553	7
554	7
556	8
557	8
558	8
559	7
560	7
561	7
562	7
563	7
564	8
565	8
566	8
567	8
570	7
571	7
572	8
573	7
574	8
575	7
576	8
577	7
580	8
581	8
582	8
583	8
584	8
585	8
586	8
587	8
590	7
591	7
592	8
593	7
594	7
595	8
596	8
597	8
598	8
599	8
600	
600	7
601	7
602	7
603	7
604	7
605	7
606	7
609	7
610	7
611	7
612	7
613	7
614	7
615	7
616	7
617	7
618	7
619	7
620	8
622	8
623	7
624	8
625	7
627	7
628	8
629	8
630	8
631	8
633	8
634	8
635	8
636	8
637	8
638	8
639	8
640	8
641	8
644	8
645	8
646	8
647	8
648	8
650	8
651	8
652	8
653	8
654	8
655	8
656	8
657	8
658	8
660	8
661	8
662	8
664	8
665	8
666	8
667	8
668	8
669	8
670	8
671	8
672	8
673	8
674	8
675	8
676	8
677	7
678	8
679	8
680	7
681	7
683	7
684	7
685	7
686	7
687	7
688	7
689	7
690	7
691	7
692	7
693	7
700	
700	2
701	2
703	2
704	2
705	2
706	2
707	2
708	2
710	4
711	4
712	4
713	4
714	2
716	4
717	4
718	4
719	4
720	4
721	4
722	4
723	4
724	4
725	4
726	4
727	4
728	4
729	4
730	4
731	4
734	4
735	4
736	4
737	4
738	4
739	8
740	4
741	4
743	4
744	4
745	4
746	4
747	4
748	4
749	4
750	4
751	4
752	4
753	4
754	4
755	4
756	4
757	4
758	4
759	2
760	4
761	4
762	4
763	4
764	4
765	2
766	4
767	4
768	4
769	4
770	2
771	2
772	2
773	2
774	2
775	2
776	2
777	2
778	2
779	2
780	1
781	2
782	2
783	1
784	1
785	1
786	2
787	2
788	2
789	2
790	8
791	8
792	4
793	4
794	4
795	4
796	4
797	4
798	4
799	4
800	
800	7
801	7
802	7
803	7
804	7
805	7
806	7
807	7
808	7
809	7
810	7
811	7
812	7
813	7
814	7
815	7
816	8
820	7
821	8
822	7
823	8
824	7
825	7
826	7
827	7
828	7
829	8
830	8
831	8
832	8
833	8
834	8
835	8
836	8
837	8
838	8
840	7
841	7
843	7
844	7
845	7
846	7
847	7
850	2
852	2
853	2
855	4
856	2
857	2
859	8
860	7
863	4
864	4
865	8
870	8
871	8
872	8
873	7
874	7
875	7
877	7
878	4
879	4
880	4
881	8
882	4
883	8
884	8
890	4
891	4
893	7
894	7
895	7
897	7
898	7
900	
900	1
901	1
902	1
903	1
904	1
905	1
906	1
907	1
908	1
910	1
911	2
912	2
913	1
914	1
915	2
916	1
917	2
918	2
920	1
921	1
922	2
923	2
924	2
925	2
926	1
927	1
928	1
930	2
931	3
932	4
933	4
934	3
935	4
936	3
937	4
939	3
940	3
941	3
943	3
944	3
945	3
946	3
947	3
948	3
949	3
950	3
951	3
952	3
953	3
954	3
955	8
956	4
957	4
958	3
959	3
960	8
961	7
970	3
971	3
972	3
973	3
974	3
975	3
976	8
977	8
978	8
979	8
980	8
981	8
982	8
983	8
984	8
985	8
986	8
988	8
989	8
990	8
991	8
992	8
993	8
994	8
995	8
996	8
997	8
998	8
999	8

*For Hawaii, Puerto Rico, and Virgin Islands, Your Insulation Zone is 1.

Table 4: **Recommended Total R-Values for Existing Houses in Eight Insulation Zones**[a]

Component	Ceilings Below Ventilated Attics		Floors Over Unheated Crawlspaces, Basements		Exterior Walls[b] (Wood Frame)		Crawlspace Walls[c]	
Insulation Zone	Oil, Gas, Heat Pump	Electric Resistance	Oil, Gas, Heat Pump	Electric Resistance	Oil, Gas, Heat Pump	Electric Resistance	Oil, Gas, Heat Pump	Electric Resistance
1	19	30	0	0	0	11	11	11
2	30	30	0	0	11	11	19	19
3	30	38	0	19	11	11	19	19
4	30	38	19	19	11	11	19	19
5	38	38	19	19	11	11	19	19
6	38	38	19	19	11	11	19	19
7	38	49	19	19	11	11	19	19
8	49	49	19	19	11	11	19	19

a. These recommendations are based on the assumption that no structural modifications are needed to accommodate the added insulation.

b. R-value of full wall insulation, which is 3 1/2 inches thick, will depend on material used. Range is R-11 to R-13. For new construction R-19 is recommended for exterior walls. Jamming an R-19 batt in a 3 1/2 inch cavity will not yield R-19.

c. Insulate crawl space walls only if the crawl space is dry all year, the floor above is not insulated, and all ventilation to the crawl space is blocked. A vapor barrier (e.g., 4- or 6-mil polyethylene film) should be installed on the ground to reduce moisture migration into the crawl space.

Vapor retarders should be used in most parts of the country. If you live in an area where the climate is predominantly hot and humid, check with an air-conditioning specialist, who may recommend that the vapor retarder be omitted or placed against exterior walls. A house in such climates needs to be evaluated to assure correct placement of the vapor retarder.

But in the cooler climates, remember to place the vapor retarder on the warm side — the lived-in side — of the space to be insulated. This location prevents the moisture in the warm indoor air from reaching the insulation.

Batts and blankets can be purchased with a vapor retarder attached. If new material is being added to insulation already in place, use batts or blankets that *do not* have an attached vapor retarder. If this type is not available, be sure to remove the vapor retarder facing between layers of insulation to allow any moisture which does get into the insulation to pass through.

For loose-fill insulation, thin 6-mil polyethylene plastic sheets are available in rolls of various widths for use as vapor retarders. In places where vapor retardant materials cannot be placed, such as in finished wall cavities being filled with blown-in insulation, the interior surface of the wall can be made vapor-resistant with a low-permeability paint, or with wallpaper that has a plastic layer.

Ventilation

Adequate ventilation in your house is important for two reasons:

- Moisture Control — No matter how well a vapor retarder is installed, some moisture may penetrate to the insulation. To avoid having this moisture affect the insulation and the surrounding structure, it must be allowed to escape to the outdoors in winter.

- Avoiding Indoor Air Pollution — When natural ventilation has been sharply reduced, as in the super-energy-efficient houses described earlier, it may be necessary to provide fresh air ventilation to avoid build-up of stale air and indoor air pollutants. Special air exchange units with heat-saving features are available for this purpose, as noted in the Publications List.

A well insulated attic must be adequately ventilated to prevent moisture accumulation. Attic ventilators, usually installed in gable faces, permit good cross-ventilation by allowing air to flow in one vent and out another. A good rule is to provide at least one square foot of unobstructed ventilation opening at each end for each 150 square feet of attic floor area. Gable vents may be supplemented with soffit vents at eaves, and with continuous ridge vents. Never cover or block vents with insulation. Take care to prevent loose-fill insulation from clogging vents by using baffles to ensure free movement of air. If you have insulated a floor above a dry crawl space, be sure to provide a positive ventilation path from the crawl space. If the crawl space walls are to be insulated, the insulation should extend in from the walls, on the ground for a

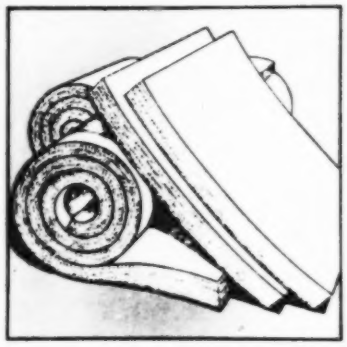
minimum of two feet, and further in cold climates. If floors are insulated, all ducts and water lines running below the insulation should be insulated as well. Insulation of band joists to the same levels recommended for crawl space walls is also recommended. See Table 4, footnote c, about precautions. Covering the bare earth in the crawl space with sheets of plastic can sharply reduce the crawl space moisture level.

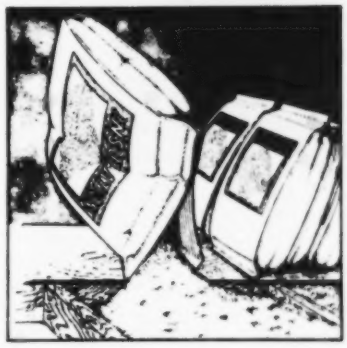
WHAT KIND OF INSULATION SHOULD YOU BUY?

Once you have located the areas in your house requiring insulation, and have determined what R-value is needed, you will need to decide what type to buy. You should consider the several forms of insulation available, their R-values, and the thickness needed. Remember, for a given type and weight of insulation, the thicker it is, the higher its R-value.

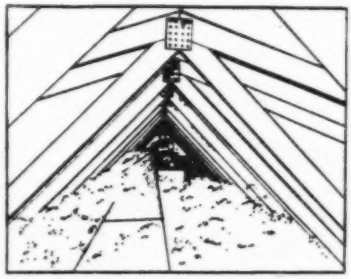
Basic Forms of Thermal Insulation

BATTS AND BLANKETS are flexible products made from glass or rock wool fibers. They are available in rolls or strips in widths suited to standard spacings of studs and joists. Blankets are continuous rolls which can be hand-cut to the desired length. Batts are pre-cut to 4-foot and 8-foot lengths, but may be trimmed to fit. Both are available with or without vapor retarder facings.





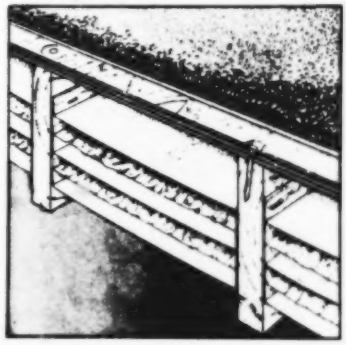
LOOSE-FILL insulations include loose fibers, coarse granules or nodules supplied in bags or bales. It can be installed by gloved hand on an open horizontal surface, or in a cavity, to the R-value desired. The granular form may be poured directly from the bag. Loose-fill insulation is made from rock wool fibers, fiberglass, cellulosic fiber, vermiculite or perlite minerals.



BLOWN-IN loose-fill insulation includes loose fibers or fiber pellets that are blown into building cavities or attics using special pneumatic equipment. Another form includes fibers that are co-sprayed with an adhesive. This latter installation cures in a few days, is resistant to settling and provides effective sealing of cavities.

PLASTIC FOAM is available as rigid boards, molded pipe-covering, or foamed-in-place, cellular materials. The latter form requires special equipment to meter, mix, and spray or extrude into place. *Urea-formaldehyde foam-in-place insulation is not recommended* for home insulation because of vapor emission, material shrinkage and resulting potential home resale problems.

RIGID BOARDS are fibrous materials, or plastic foams, pressed or extruded into board-like forms. These provide thermal and acoustical insulation, strength with low weight, and coverage with few heat loss paths. Such boards may be faced with a reflective foil that reduces heat flow when facing a dead air space.



REFLECTIVE INSULATIONS are fabricated from aluminum foils with backings applied to provide a series of closed air spaces with highly reflective surfaces. Its insulating value is derived from the number of heat-reflective surfaces separated by air spaces. It is more effective in hot climates than in cooler climates, and is typically located between roof rafters, floor joists, or wall studs. The R-value depends on the heat flow direction and is most effective in reducing downward heat flow. Single foil radiant barriers placed in attics reduce heat transfer from roofs.

MAKING YOUR SELECTION

The type of insulation you use will be determined by the nature of the spaces in the house that you plan to insulate. For example, since you cannot conveniently "pour" insulation into an overhead space, batts or blankets are used between the joists of an unfinished basement ceiling. The most economical way to fill closed cavities in finished walls is with blown-in insulation applied with pneumatic equipment. Table 1 provides a concise summary of the appropriate applications for the various types of thermal insulation.

It is important to know that the different forms of insulation can be used together to advantage. For example, you can add batt or blanket insulation over loose-fill insulation, or vice-versa. However, material of higher density (weight per unit volume) should not be placed on top of lower density insulation that is easily compressed. Doing so will reduce the thickness of the material underneath and thereby lower its R-value.

CHECK THE LABEL BEFORE YOU BUY

No matter what kind of insulation you buy, check the information on the product label to make sure the material meets either Federal or ASTM (American Society for Testing and Materials) specifications. A good insulation label should have a clearly stated R-value, and information about fire-resistant properties. An informative label should state:

- The type of insulation material;
- The R-value supplied;
- The types of spaces that can be insulated;
- The fire specification that it meets;
- Safety precautions in application and use;
- The quantity in the package;
- The name and address of the manufacturer or distributor.

CAN YOU DO IT YOURSELF?

Whether or not you install the insulation yourself depends on the structural design of your house and the type of materials used in its construction. Most houses in the United States are of wood-frame construction (2"x4" wood stud exterior walls), covered with various interior finish materials, such as gypsum drywall or other paneling. Outside sheathing materials (which may or may not have a significant R-value) include wood, brick, metal or plastic siding, and fiber-cement shingles.

Placing insulation in the attic floor of wood-frame houses is usually easy, requiring only laying the material between the parallel joists of the frame. Bear in mind that insulation placed between joists, rafters, and studs does not retard heat flow through the exposed wood itself. This flow is called thermal bridging. Thermal bridging can be reduced by adding sufficient loose-fill insulation thickness, or cross-installed batts, to cover the wood completely.

Installing insulation in the cavity of exterior walls is more difficult. It usually requires the services of a contractor who has special equipment for blowing fiber granules or pellets into the cavity through small holes cut through the sidewall, which later are closed.

In some houses with low-pitch roofs, it is difficult to gain access to all of the attic floor, so blowing equipment may be needed to place insulation in relatively inaccessible areas.

It is sometimes feasible to install rigid insulation on the outdoor side of masonry sidewalls such as concrete block, concrete, or stone. When new siding is to be installed, always consider adding thermal insulation with high resistance under it. Generally the services of a qualified contractor are needed to make such installations.

Adding thermal insulation to a mobile home is complex and usually requires installation by specialists.

IF YOU DO IT YOURSELF

These do-it-yourself instructions cover installation of batts and blankets, loose-fill or poured-in materials, rigid boards, and reflective insulations. *Before beginning the work, read and observe the following precautions:*

- *Wear clothing adequate to protect against skin contact and irritation.* A long-sleeved shirt with collar and cuffs buttoned, gloves, hat, glasses, and dust mask are advisable in all do-it-yourself insulation projects.
- *Do not cover or hand-pack insulation around bare stove pipes, electrical fixtures, motors, or any heat-producing equipment such as recessed lighting fixtures.* Electrical fire-safety codes prohibit the installation of thermal insulation within three inches of a recessed fixture enclosure, wiring compartment, or ballast, or above the fixture so that it will trap heat and prevent free circulation of air, unless the fixture is identified by label as suitable for insulation to be in direct contact with the fixture. THIS IS FOR FIRE SAFETY.
- *Do not cover attic eave vents with insulation.* Proper ventilation, especially in attics, must be maintained to avoid overheating in summer and moisture build-up all year long.

Batt and Blanket Insulation

Installing batts and blankets is fairly easy. On walls, begin at the top and work down. Place the vapor retarder toward the lived-in side, except in hot, humid climates. Fit the insulation between the wood frame studs, cut off the excess length where necessary, and secure the insulation by stapling or tacking the flanges of the vapor retarder to the edge of the stud. Avoid stapling to the side of the stud because that leaves gaps, enabling water vapor to bypass the retarder. On unfinished attic floors, work from the perimeter toward the center. Fit the insulation between the joists and be sure to insulate the trap or access door. Although the area of the door is small, an uninsulated attic door will reduce energy savings substantially, because air will flow through much as water drains quickly through a bathtub drain.

When a fiberglass blanket is used to insulate the inside of basement walls, it is necessary to attach wood furring strips to the walls by nailing or bonding, or to build an interior stud-wall assembly on which the interior finish can be attached after insulation installation. The added structure should be of sufficient thickness to allow the insulation R-value to be achieved.

Batts and blankets must be cut and fit around such obstructions as cross-bracing between floor joists, and window frames in walls. Strips of insulation may be cut off and stuffed into tight spaces by hand. Do not hand-pack insulation around hot spots such as recessed light fixtures. *THIS COULD CAUSE HEAT BUILD-UP AND A FIRE HAZARD.*

When batts or blankets are used overhead, such as above an unheated crawl space or basement, fit the insulation between the beams or joists and push it up against the floor overhead as securely as possible without excessive compaction of the insulation. The insulation can be held in place, either by tacking chicken wire (poultry netting) to the edges of the joist, or with snap-in wire holders. Don't forget to place insulation against the perimeter that rests on the sill plate (See Figure 1).

Rigid Board Insulation

When rigid foam insulation boards are used to insulate the interior of masonry basement walls, they do not require added vapor retarder treatment. If foil-faced board is used, the foil side is placed toward the room. To install boards, wood furring strips should be fastened to the wall first. These strips provide a nailing base for attaching interior finishes over the insulation. Fire safety codes may require that a gypsum board finish, at least 1/2-inch thick, be placed over foam plastic insulation. One can use recommended adhesives to attach the rigid board to both the wall and to the gypsum board.

Loose-Fill Insulation

This insulation can be installed by blowing it into place with pneumatic equipment, or simply by pouring it from bags into the spaces between ceiling joists, breaking any lumps and spreading it evenly. When using loose-fill insulation in new construction, install a vapor retarder on the living side (see earlier section on moisture control). When loose-fill is used as additional insulation, either placed over existing loose-fill or over batts or blankets already installed with vapor retarder, do not install an additional vapor retarder.

Loose-fill insulation must be prevented from shifting into vents, eaves, or from contacting heat-producing equipment (such as recessed lighting fixtures). Block off those areas with baffles or retainers to hold the loose-fill insulation in place.

Reflective Insulation

Installing reflective insulation is similar to placing batts and blankets. Some types of reflective insulation come in flat layers which are then opened up in accordion-like fashion to form essential air spaces between reflective surfaces. Proper installation is very important if the insulation is to be effective. Study and follow exactly the instructions of the manufacturer. Usually, reflective insulation materials have flanges that are to be stapled to joists in attic or floor, or to wall studs. Be careful not to compress the accordion structures, because this will reduce the necessary air space and thus lower the thermal resistance. Since reflective foil will conduct electricity, one must avoid making contact with any bare electrical wiring.

IF YOU HAVE IT DONE PROFESSIONALLY

You should obtain cost estimates from several contractors for a stated R-value. Make sure you describe the job in writing in the same terms to each one. Remember that you want good quality materials and labor, as well as price. Do not be surprised to find the quoted prices for a given R-value installation to vary by more than a factor of two. When you talk to a contractor, talk of R-values. Don't forget that R-values are determined by material type, thickness, and installed weight per square foot, not by thickness alone.

Bags of insulating material used by the contractor should be marked with R-value for the area to be covered. Although these figures may differ among manufacturers, the area figure will tell you the right number of bags to be used for loose-fill. Similarly, packages of other types of insulation should be identified by its R-value. It is important that you check that the proper amount is installed in your residence. Asking the contractor to attach vertical rulers to the joists prior to a loose-fill installation may help assure a proper installation.

OTHER PLACES IN YOUR HOME FOR ADDED INSULATION

Don't overlook two other areas in your home where energy can be saved — your hot water tank and the ductwork of the heating and air-conditioning system.

Your hot water tank loses heat to the surrounding space. Wrapping insulation around the tank reduces this heat loss, which, in turn, reduces the energy needed to keep the water at the desired temperature. For a 40- to 50-gallon hot water tank, about 10% of the yearly cost for heating water can be saved ths way.

You can buy an insulation kit with do-it-yourself instructions for your hot water tank. Or you can wrap the tank with insulation. The objective is to cover all exposed surfaces of the tank, *except for certain critical areas that must be left uncovered.* Do not cover the drain, the thermostat access panel, or the relief valve on top of the tank of electric water heaters. On gas water heaters, a crucial warning must be heeded: DO NOT COVER AIR INLETS, PIPES, CONTROLS, RELIEF VALVES, OR THE FLUE AT THE TOP OF THE HEATER. If you are not sure about the various critical openings on gas water heaters, use a manufactured kit with holes pre-cut for these openings. It is important also that the insulation be affixed to the tank so that it cannot slip down and cover those openings later. A mistake here could cause a fire or explosion.

If water lines and the ducts of your heating or air-conditioning system run through unheated or uncooled spaces in your home, such as attic or crawl spaces, then the water lines and the ducts should be insulated. First check the ductwork for leaks, and seal joints and leaks with duct tape before insulating. This is an important step, because air leakage to or from the ducts will offset the savings you would expect from added insulation. Then wrap the ducts with about 3 1/2 inches of duct wrap insulation having a vapor retarder facing on the outer side. All joints where sections of insulation meet should have overlapped facing and be tightly sealed with duct tape; but avoid compressing the insulation, thus reducing its thickness and R-value. If space permits, this type of insulation will pay for itself in energy saved in many parts of the country.

INFORMATION SERVICES

Reference Sources

Additional and more detailed information about thermal insulation materials and installation and about energy conservation in buildings is available. Write to the agencies and organizations listed below. Your public utility company can also provide information and assistance on home energy conservation practices and materials.

U.S. Department of Energy
Office of Scientific and
Technical Information
P.O. Box 62
Oak Ridge, TN 37830

Conservation and Renewable Energy Inquiry and Referral Service
P.O. Box 8900
Silver Spring, MD 20907
Phone: 800/523-2929
800/233-3071

Mineral Insulation Manufacturers Association
1420 King Street, Suite 410
Alexandria, VA 22314
Phone 703/684-0084

National Association of Home Builders
15th & M Streets NW
Washington, DC 20005
Phone: 202/822-0200

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161

Insulation Contractors of America
15819 Crabbs Branch Way
Rockville, MD 20855
Phone:; 301/926-3083

National Institute of Building Sciences
1015 Fifteenth St. NW, Suite 700
Washington, DC 20005
Phone: 202/347-5710

Perlite Institute, Inc.
600 S. Federal St.
Suite 400
Chicago, IL 60605
Phone: 312/922-2062

Vermiculite Association
52 Executive Park South
Atlanta, GA 30329
Phone: 404/321-5309

Society of the Plastic Industry
355 Lexington Avenue
New York, NY 10017
Phone: 212/503-0600

Cellulose Insulation Standards Enforcement Program
610 Centre City Offices
Dayton, OH 45402
Phone: 513/222-1024

Reflective Insulation Manufacturers Association
P.O. Box 2453
Irwindale, CA 91706
Phone: 818/960-6491

Publications

The following publications offer specific information on the costs, savings factors, and installation methods of energy-saving home improvements:

Available from:
Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402

In the Bank...Or Up the Chimney**
U.S. Dept. of Housing and Urban Dev.
Stock No. 023-000-00411-9
Price: $3.00

Making the Most of Your Energy Dollars in Home Heating and Cooling
U.S. National Bureau of Standards
Stock No. 003-003-01446-0
Price: $2.75

Find and Fix the Leaks; A Guide to Air Infiltration Reduction
U.S. Dept. of Energy
Stock No. 061-000-00538-2
Price $2.50

Heat Recovery Ventilation for Housing DOE/CE/1509-9, March 1984
U.S. Dept. of Energy
Stock No. 061-000-00631-1
Price $2.25

Available from:
Small Homes Council
Univ. of Illinois
One East St. Mary's Road
Champaign, IL 61820

Energy Package–A group of eight publications pertinent to energy use and conservation in homes. Price: $3.00

More for Your Money–Home Energy Savings
Price: $2.50

Available from:
Mineral Insulation Manufacturer Assoc.
1420 King Street, Suite 410
Alexandria, VA 22314

How to Save Money by Insulating Your Home
Pricr: $.50

Insulation Manual: Homes, Apartments
Price: $3.00

This publication also available as a reprint titled **Insulate Your Home and Save Fuel, from Dover Publications, Inc. 180 Varick St., New York, NY 10014
Price: $2.75